Bacteria TMDL in the Piney Run Watershed

Final Public Meeting

March 18, 2004

Presentation Overview

1. **Overview of Virginia's TMDL Program**
2. Applicable Water Quality Standard
3. Piney Run Impairment
4. Bacteria Source Tracking (BST) Results
5. Bacteria Source Assessment
6. TMDL Development Approach
7. TMDL and Allocations

What is a TMDL ?

- TMDL stands for **Total Maximum Daily Load**
- A TMDL is a **pollution budget**
- A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet **water quality standards**
- A TMDL includes an **allocation** of that maximum amount to the pollutant's sources

TMDL Equation

A TMDL is summarized as:

TMDL = Sum of WLA + Sum of LA + MOS

Where:

- TMDL = Total Maximum Daily Load
- WLA = Waste Load Allocation (point sources)
- LA = Load Allocation (nonpoint sources)
- MOS = Margin of Safety

How is a TMDL developed?

- Identify all sources of a given pollutant within the watershed
- Calculate the amount of pollutant entering the stream from each source
- Calculate the pollutant reductions needed, by source, to attain water quality standards
- Allocate the allowable loading to each source and include a margin of safety

When are TMDLs needed?

- State and federal law require TMDLs to be developed for **impaired** waters
- Impaired waters do not meet applicable **water quality standards** (WQS)
- Waters that do not meet WQS do not support their **designated use(s)**
- For bacteria impairments, the designated use that is affected is the **recreational use**

Regulatory Basis of TMDLs

- TMDLs required by Federal and State law
  - 1972 Clean Water Act (CWA), Section 303(d)
  - 1997 Water Quality Monitoring, Information and Restoration Act (WQMIRA)
- 1998 lawsuit filed by the American Canoe Association and the American Littoral Society against EPA for failure to comply with CWA §303(d) in Virginia
- 1999 Consent Decree requiring EPA and Virginia to complete 636 TMDLs by 2010

Regulatory Requirements

- Both state and federal law require:
  - Establishment of water quality standards
  - Monitoring of water quality in surface waters
  - Assessment of water quality in surface waters
  - Listing of waters that do not meet water quality standards (impaired waters)
  - Development of TMDLs for impaired waters
- State law requires, and federal law recommends:
  - Development of a TMDL Implementation Plan

Roles of DEQ and DCR in TMDL and IP Development

- DEQ is the lead for TMDL development, including submittal to EPA
- DCR is the lead for TMDL Implementation Plan (IP) development
- DEQ is responsible for ensuring public participation in the TMDL program

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Water Quality Standards

- Water Quality Standards (WQS):
  - set by states and approved by EPA
  - set **numeric** and **narrative** limits on pollutants
  - consist of **designated use(s)** and water quality **criteria**
- Purpose of WQS:
  - **protection** of 5 designated uses (aquatic life, fish consumption, shellfish, recreation, drinking water)
  - **restoration** of state waters to meet criteria

Applicable Designated Use

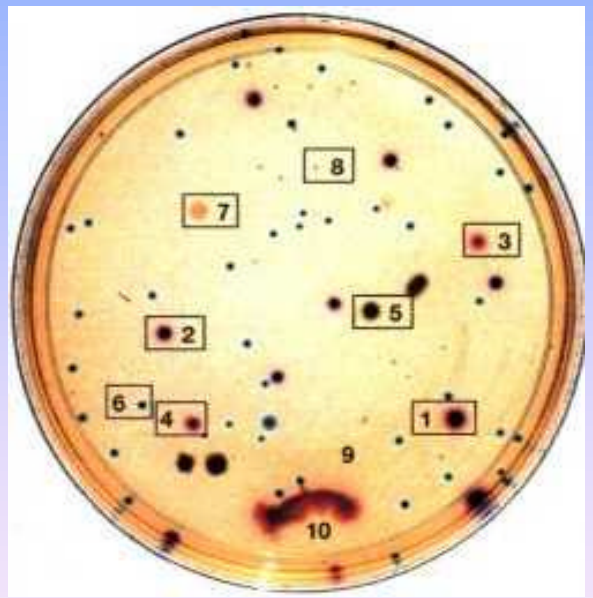
- All surface waters in Virginia are currently designated for **primary contact recreation** (e.g. swimming)
- In March 2003, a **secondary contact recreation** use designation (e.g. wading, fishing) was added to the WQS
  - Five times the primary contact criteria
  - Individual waters will only be considered for reclassification after TMDL implementation has been tried using reasonable BMPs
  - Approved by EPA and effective Feb. 12, 2004

Pollutant of Concern

- ***Fecal bacteria*** are found in the digestive tract of humans and warm blooded animals
- Fecal bacteria are an indicator of the potential **presence of pathogens** in waterbodies
- The presence of fecal bacteria in water samples is a strong indicator of recent **sewage or animal waste contamination**

Sampling for Bacteria

- Stream samples are collected in sterile 125 mL sample bottles
- Samples are filtered to deposit bacteria on filters
- Filters are incubated, allowing individual bacteria to grow into visible colonies
- Colonies are counted to give a concentration of colony forming units (cfu) per 100 mL



Old Criteria

- Indicator species: **fecal coliform**
  - used in listing Piney Run
- **Instantaneous max**: **1,000 cfu/100 mL**
- Applicable for data sets with 1 or fewer samples in 30 days
- **Geometric mean: 200 cfu/100 mL**
- Applicable for data sets with 2 or more samples in 30 days

New Criteria

- Indicator species for freshwater: ***E. coli***
  - change in indicator species from fecal coliform to ***E. coli*** (fresh water)
  - *E. coli* bacteria are a **subset of fecal coliform** bacteria and correlate better with swimming-associated illness

- **Instantaneous max**: **235 cfu/100 mL**
- Applicable for all data sets; no samples may exceed the maximum

- **Geometric mean: 126 cfu/100 mL**
- Applicable for data sets with 2 or more samples in a calendar month

Comparison of the Old Fecal Coliform and New *E. coli* Criteria

Old FC (cfu/100mL)	Interim FC (cfu/100mL)	FC translated to EC* (cfu/100mL)	New EC (cfu/100mL)
200	200	129	126
	400	243	235
1,000		565	

* Based on regression model between 493 dual data points

Note: FC = Fecal Coliform, EC = *Escherichia Coli*

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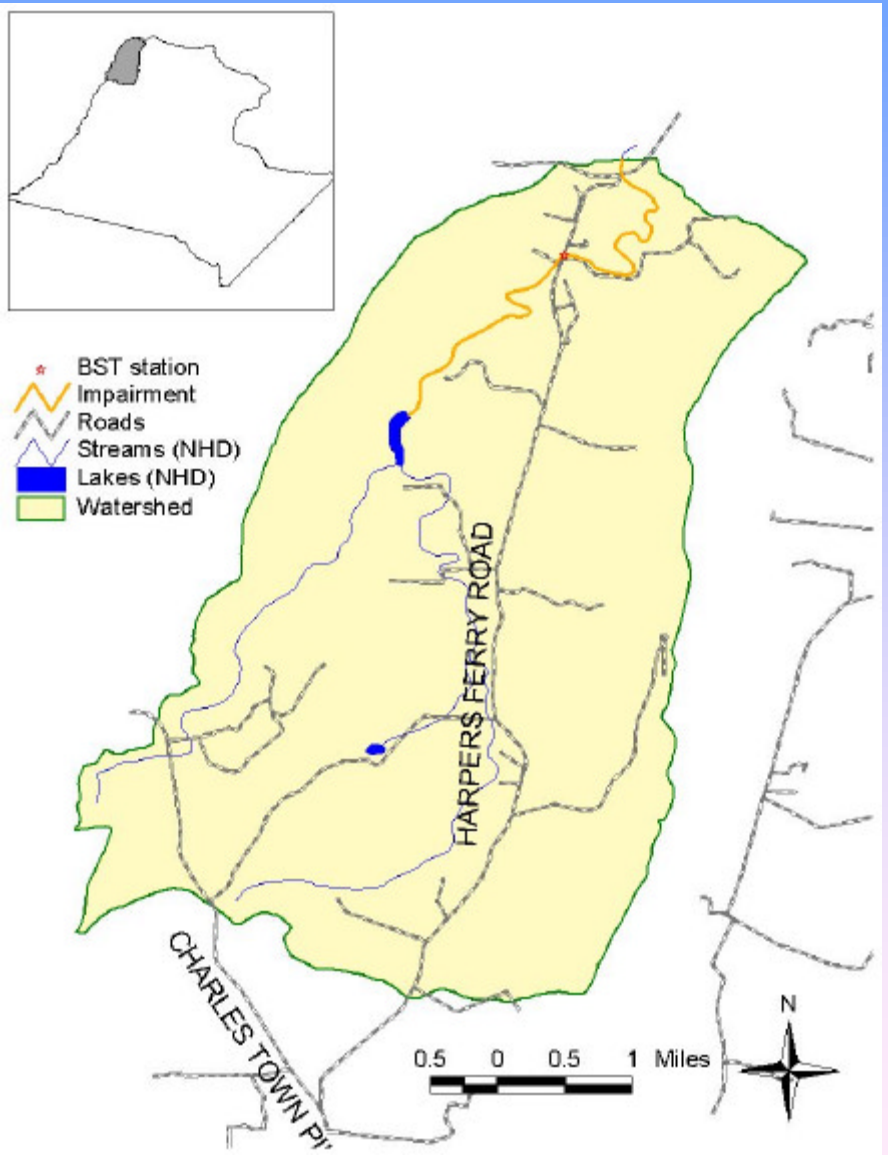
Impairment in the Piney Run Watershed

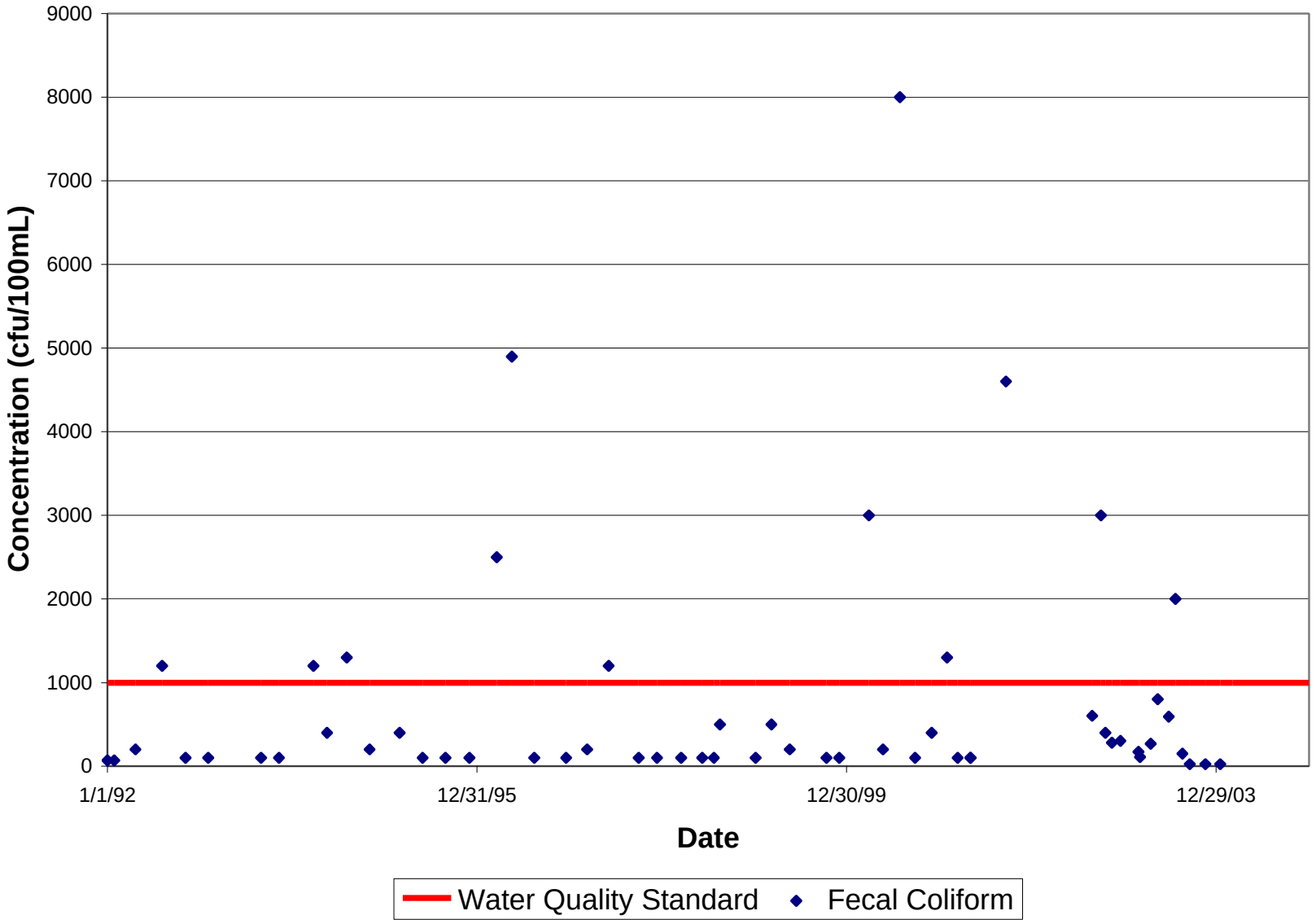
WATER BODY	CAUSE	STREAM NAME	LENGTH (Miles)	YEARS LISTED
VAN-A01R	Bacteria	Piney Run (from mouth of unnamed lake to confluence with Potomac River)	3.52	1998, 2002

Map of the Piney Run Watershed

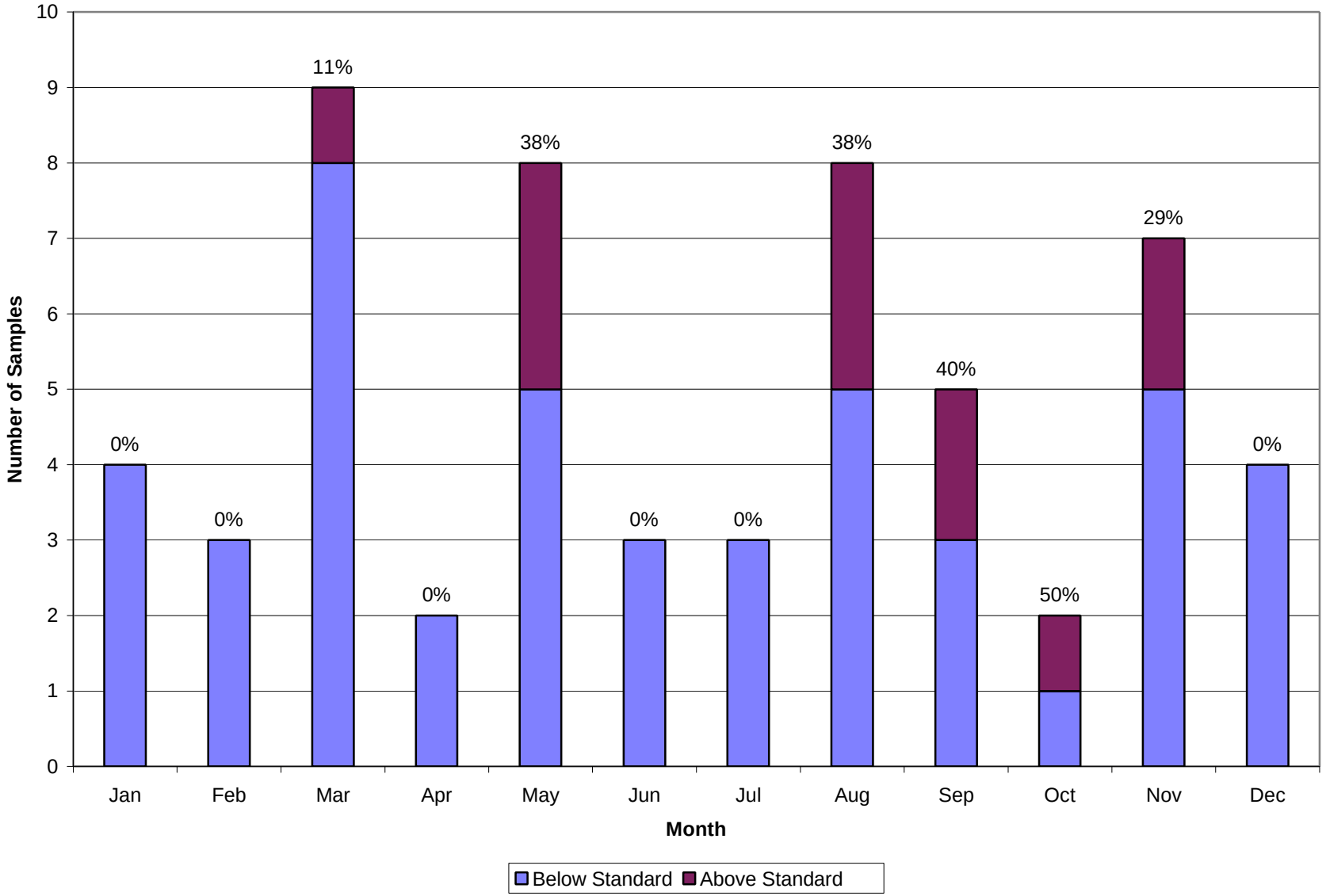


- DEQ monitoring station: 1APIA001.80
- USGS flow gage: 01636690
- 2002 305(b) results: 5 of 22 samples (23%) exceeding 1000 cfu/100mL
- 2000 305(b) results: 5 of 20 (25%)
- 1998 305(b) results: 5 of 19 (26%)

Fecal Coliform Data at 1APIA001.80



Seasonal Distribution of Fecal Coliform Data at 1APIA001.80



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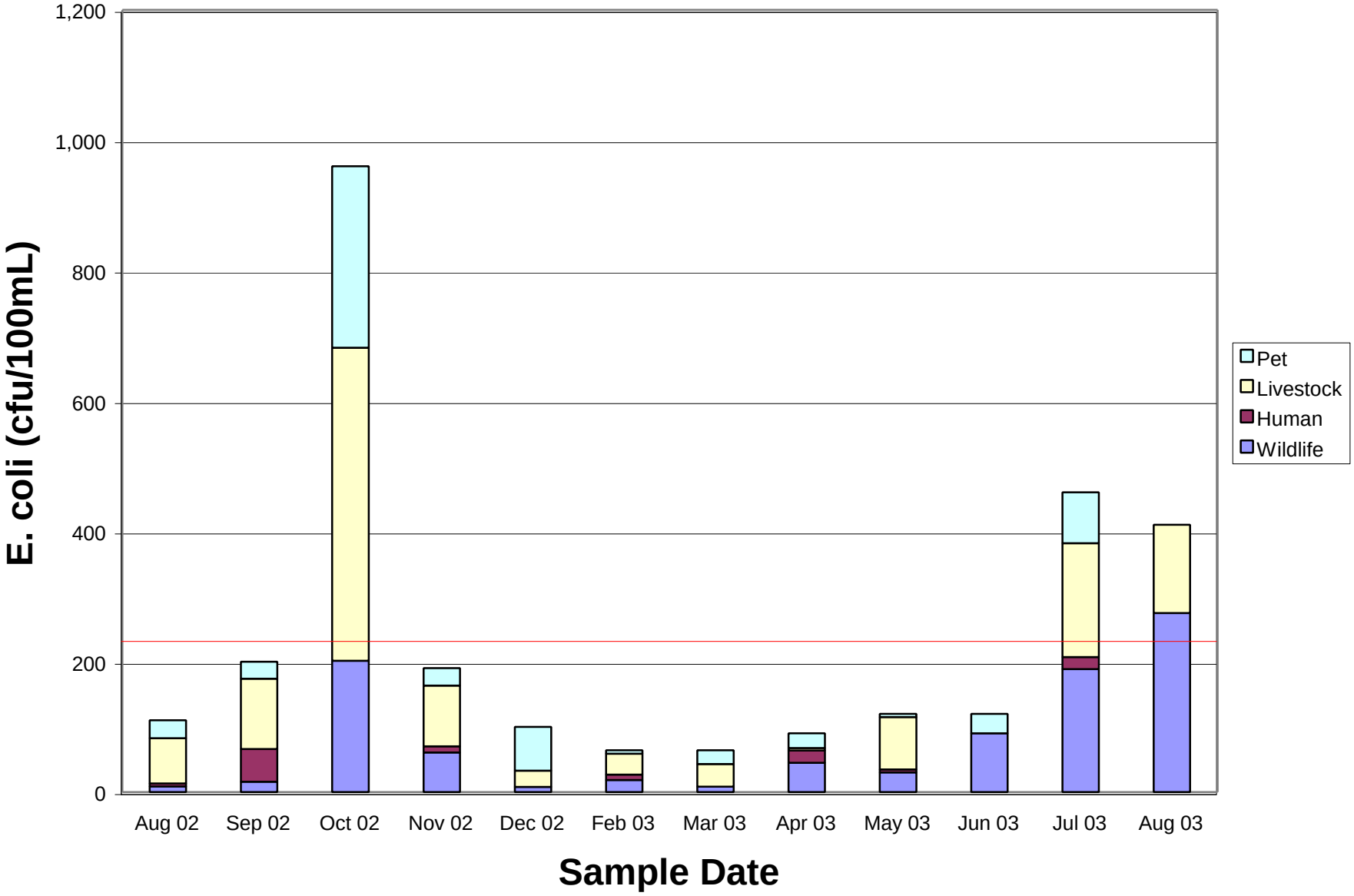
Bacteria Source Tracking on Piney Run

- Monthly sampling at Station 1APIA001.80 from August 2002 to August 2003
  - Simultaneous enumeration of E. coli and Fecal Coliform in ambient water samples
  - Completion of the BST Study finalized transition from Fecal Coliform to *E. coli* standard
- Antibiotic Resistance Analysis (ARA)
  - Collection of samples from known sources
  - Analysis of known sources to build source library
  - Identification of unknown sources by comparing ARA results to the source library

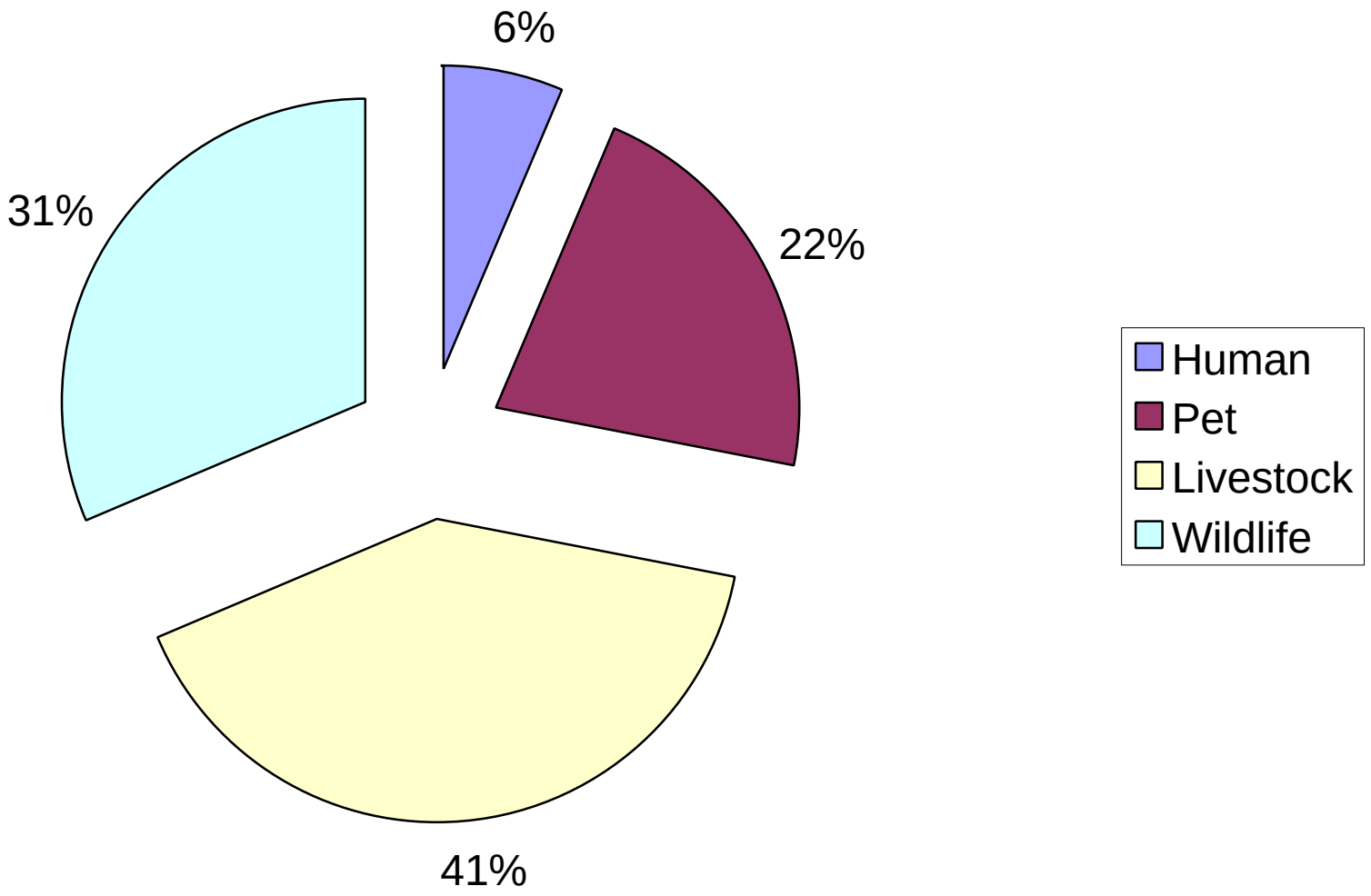
BST Results for 1APIA001.80



BST Results for 1APIA001.80

Sample Date	Fecal Coliform (cfu)	*E. coli* (cfu)	BST Distribution			
			Wildlife	Human	Livestock	Pet
08/27/2002	110	110	8%	4%	63%	25%
09/30/2002	280	200	8%	25%	54%	13%
10/17/2002	960	960	21%	0%	50%	29%
11/13/2002	190	190	32%	5%	49%	14%
12/16/2002	100	100	8%	0%	25%	67%
02/25/2003	64	64	29%	13%	50%	8%
03/04/2003	64	64	13%	0%	54%	33%
04/15/2003	90	90	50%	21%	4%	25%
05/12/2003	120	120	25%	4%	67%	4%
06/25/2003	120	120	75%	0%	0%	25%
07/22/2003	460	460	41%	4%	38%	17%
08/18/2003	410	410	67%	0%	33%	0%
		Average	31%	6%	41%	22%
		Standard Deviation	23%	9%	22%	18%

BST Results for Piney Run



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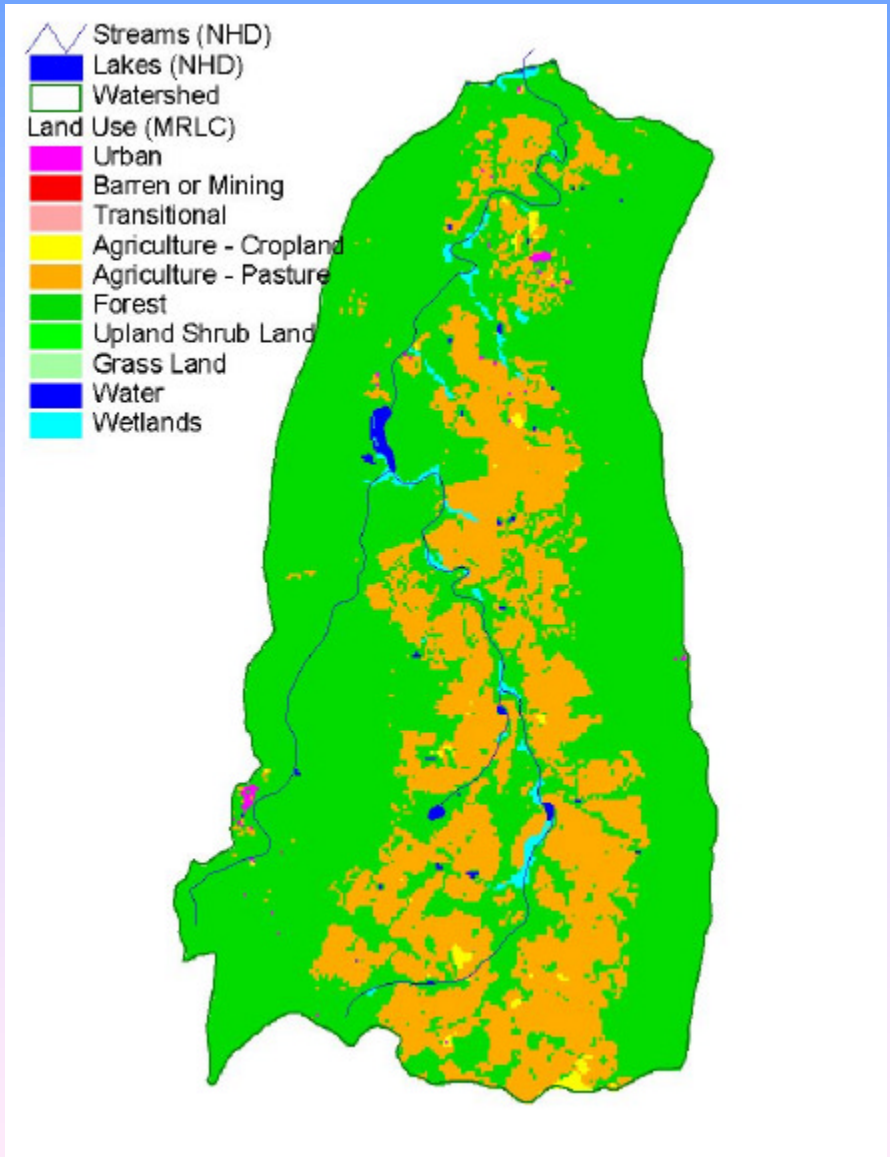
Land Use in the Piney Run Watershed

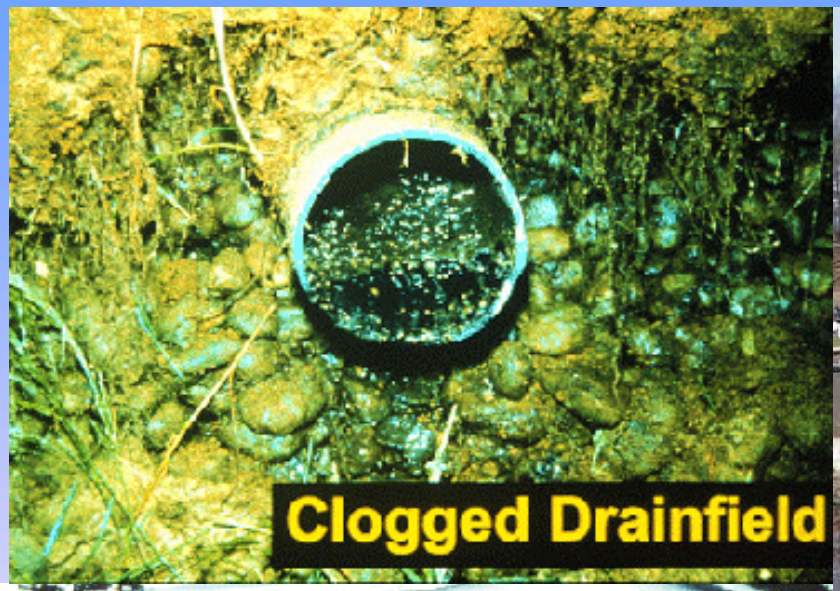


MRLC Land Use	Piney Run	
	Acres	Percent
Cropland	48	0.5%
Pasture	2,616	26.9%
Barren or Mining	0	0.0%
Forest	6,908	71.0%
Transitional	1	0.0%
Urban	20	0.2%
Water	36	0.4%
Wetlands	104	1.1%
Total	9,731	100.0%

Potential Sources of Bacteria in Piney Run

- Humans/Pets
  - Straight Pipes
  - Septic Systems
  - Biosolids
  - Permitted Point Sources
  - Pets
- Livestock
  - Direct Deposit to Land and Streams
  - Land Application
- Wildlife
  - Direct Deposit to Land and Streams

Potential Human and Pet Sources



Estimated Point Sources

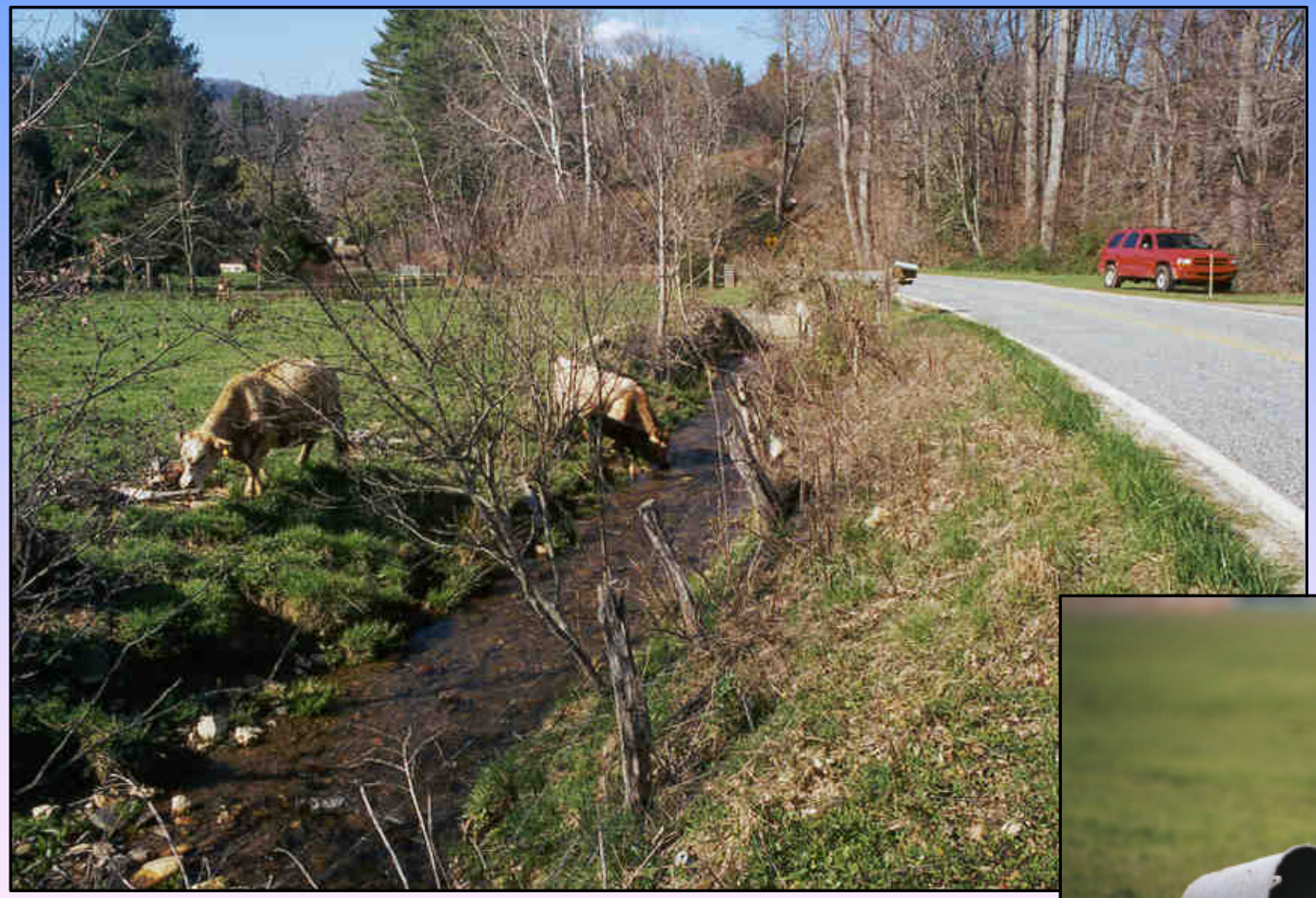
VPDES Permit Number	Facility Name	Receiving Stream	Watershed ID	Design Flow (gal/day)	Effluent Limit (cfu/100 ml)	Wasteload Allocation
VAG406106	Business	Piney Run	VAN-A01R	1,000	126	1.74×10^9
VAG406249	Business	Piney Run, UT	VAN-A01R	1,000	126	1.74×10^9
			Existing WLA	2,000	126	3.48×10^9

Estimated Human and Pet Sources

Source	Population	Waste Production Rate	Waste Fecal Coliform Density	Total Est. Annual Fecal Production
Straight Pipes	9 households x 2.6 people/household = 23.4 people	2.00 x 10^9 cfu/day/person * x 365 days/yr = 7.30 x 10^{11} cfu/yr/person		1.71 x 10^{13} cfu/yr
Failing Septic Systems	44 systems x 2.6 people/system = 114.4 people	75 gal/day/person x 37.85412 100mL/gal x 365 days/yr = 1.04 x 10^6 100mL/yr/person **	1.04 x 10^6 cfu/100mL ***	1.23 x 10^{14} cfu/yr
			Total Human	1.35 x 10^{14} cfu/yr
Dogs	411 dogs	450 g/day/dog *** x 365 days = 1.64 x 10^5 g/yr/dog	4.8 x 10^5 cfu/g ***	3.24 x 10^{13} cfu/yr
Cats	508 cats	19.4 g/day/cat *** x 365 days = 7.08 x 10^3 g/yr/cat	9 cfu/g ***	3.24 x 10^7 cfu/yr
			Total Pets	3.24 x 10^{13} cfu/yr

* Metcalf and Eddy, 1991
** Geldreich, 1978 (A conversion factor of 37.85412 was used to convert gallons to 100mL)
*** MapTech, 2002 (Catoctin Creek TMDL Report)

Potential Livestock Sources



Estimated Livestock Sources

Source	Population		Waste Production Rate** (lbs/animal/day)	Fecal Density** (cfu/g)	Total Fecal Production*** (cfu/yr)
	Loudoun County	Piney Run			
Cattle and Calves	32,650	500	46.4	1.01×10^5	3.88×10^{14}
Beef Cows	16,667	225	46.4	1.01×10^5	1.75×10^{14}
Milk Cows	504	0	120.4	2.58×10^5	0
Hogs and Pigs	869	0	11.3	4.00×10^5	0
Sheep and Lambs	1,923	30	2.4	4.30×10^4	5.13×10^{11}
Layers	2,454	50	1.40×10^8 (cfu/animal/day) ****		2.56×10^{12}
Broilers	0	0	1.40×10^8 (cfu/animal/day) ****		0
Horses	15,800 *	350	51.0	9.40×10^4	2.78×10^{14}
				Total Livestock	8.44×10^{14}

* 2001 Virginia Equine Report
** MapTech, 2002
*** A conversion factor of 453.6 was used to convert pounds to grams
**** ASAE, 1998

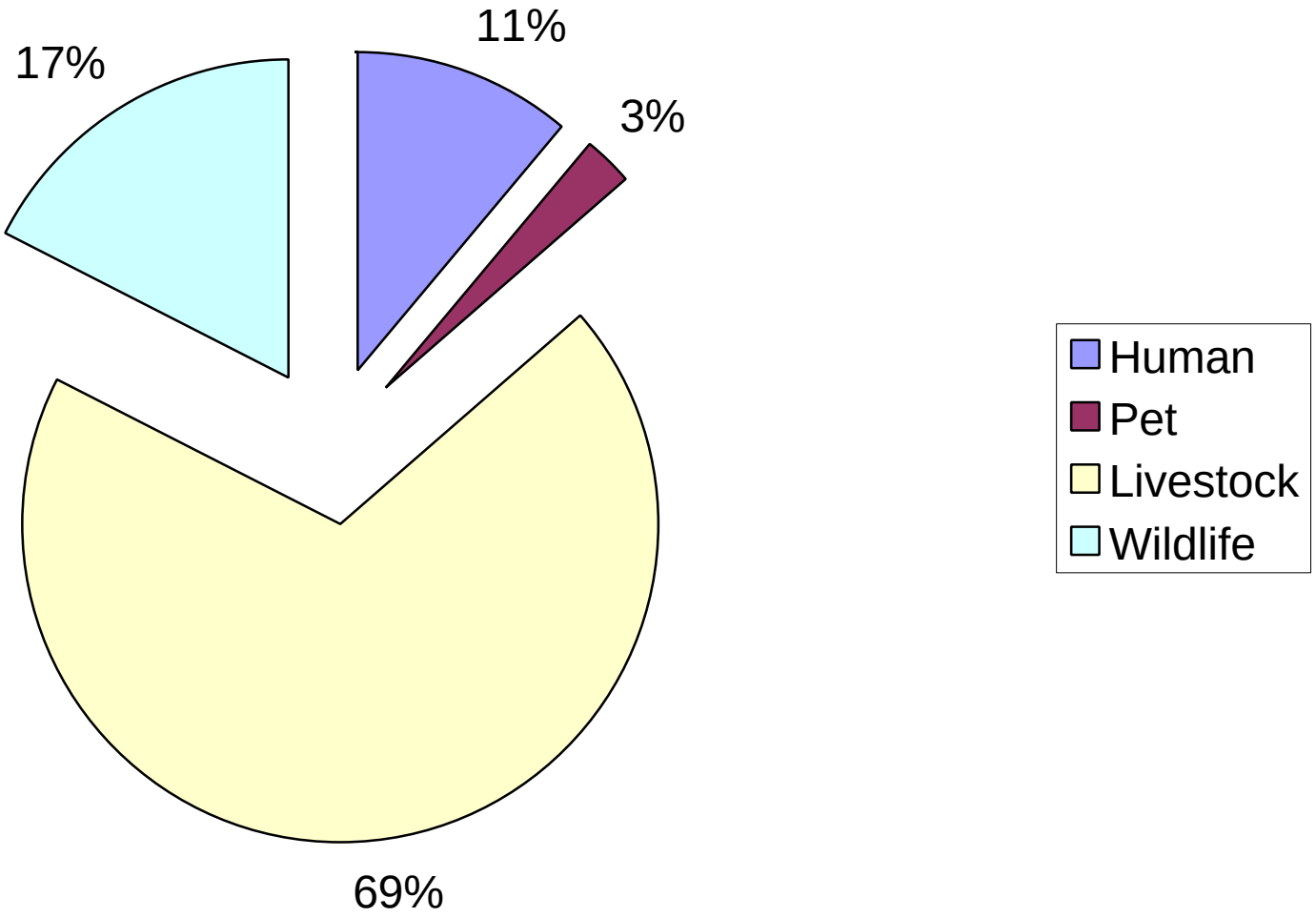
Potential Wildlife Sources

Estimated Wildlife Sources

Source	Population Density **	Habitat	Watershed Population (animals)	Waste Production Rate ** (g/animal/day)	Fecal Density ** (cfu/g)	Fecal Coliform Production (cfu/yr)
Deer	0.168 an/ac	9,592 ac	1,611	772	380,000	1.73×10^{14}
Raccoon	0.070 an/ac	1,698 ac	119	450	2,100,000	4.10×10^{13}
Beaver	9.600 an/mi	25.8 mi	132	200	1,000	9.60×10^{9}
Turkey	0.010 an/ac	6,908 ac	69	320	1,332	1.07×10^{10}
Goose	0.020 an/ac	1,698 ac	66	225	250,000	6.97×10^{11}
Duck	0.008 an/ac	193 ac	2	150	3,500	2.96×10^{8}
					Total Wildlife	2.14×10^{14}

** MapTech, 2002

Bacteria Production Results for Piney Run



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What is Load Duration Analysis?

- Less complex spreadsheet model for TMDL development
- Approach proposed for bacteria TMDLs in small watersheds
- Model requires
  - stream flow data
  - ambient water quality data, and
  - bacteria source tracking data (for pollutant source identification and loading allocations)

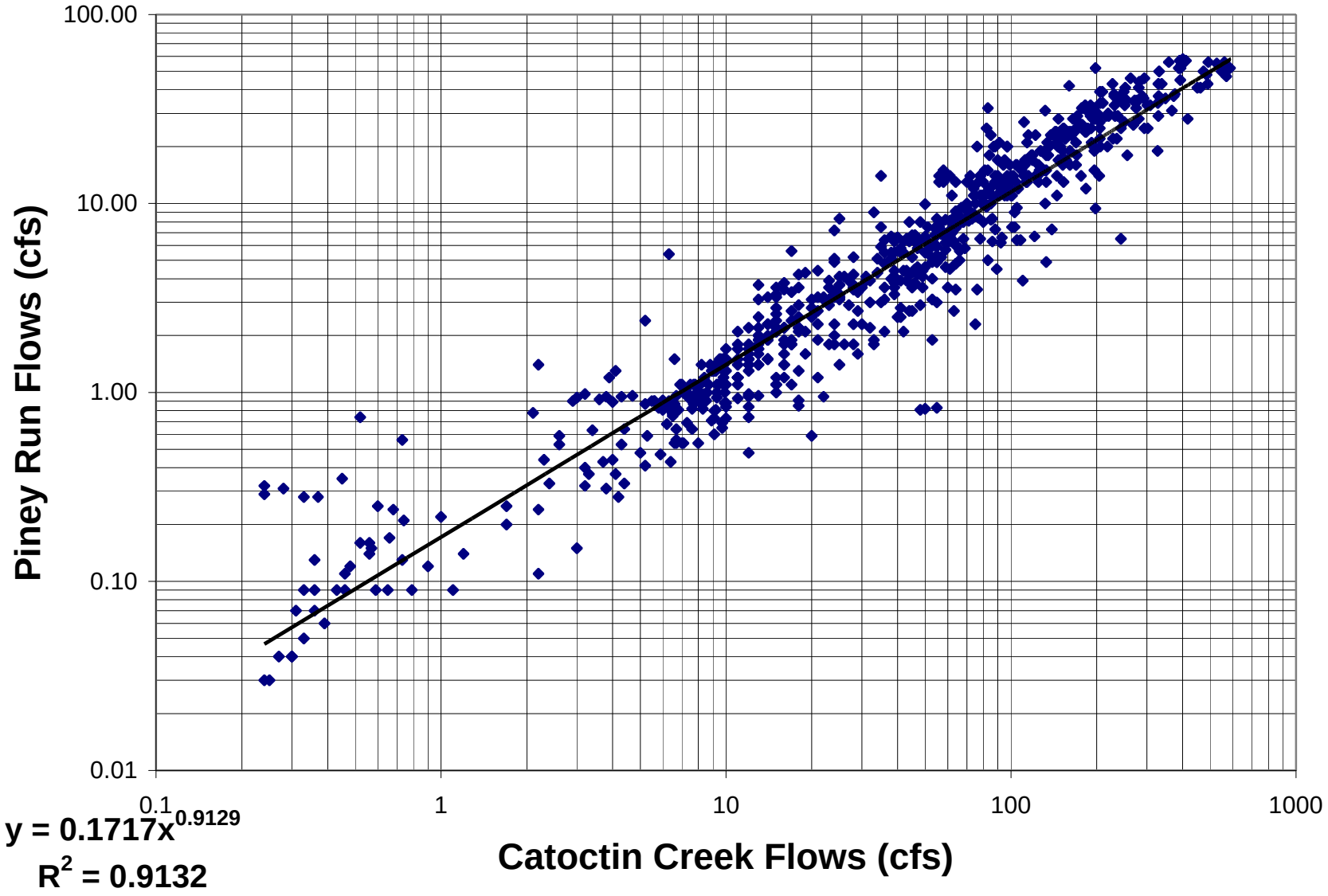
Development of Flow Duration Curve for Piney Run

- Piney Run has a USGS flow gaging station that was established in 2001
- In order to include the time period that led to the listings (1/1/1996 to 12/31/2000 for the most recent assessment), the flow record must be extended

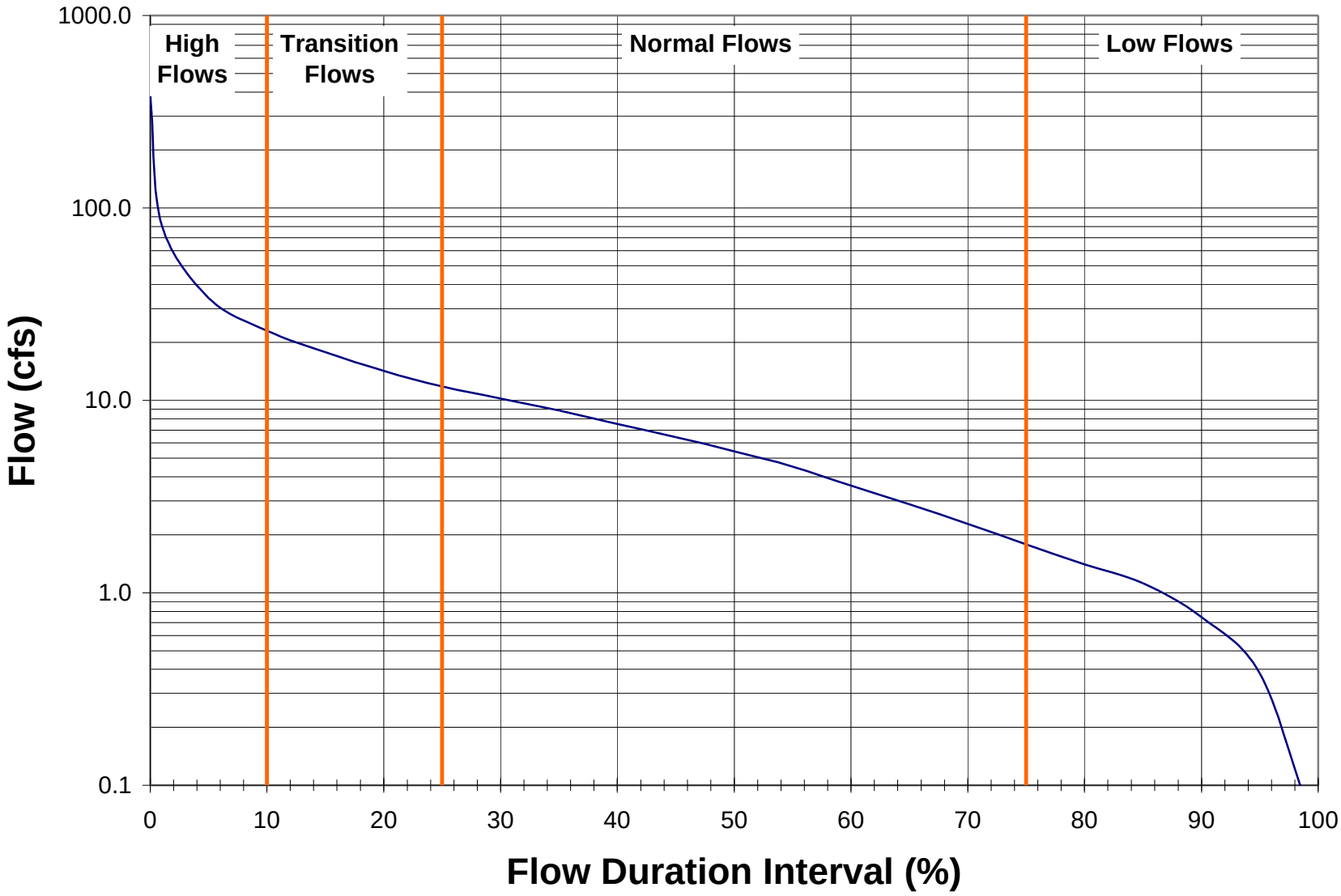
Reference Stream Selection

- Flows were correlated with Catoctin, Goose and Passage Creeks
- The period from 1988 to present was used
- Piney Run flows correlated best with Catoctin Creek (0.9318)
- Flow regression equations were then used to generate continuous flow records (1988-03)

Piney Run Flow Regression



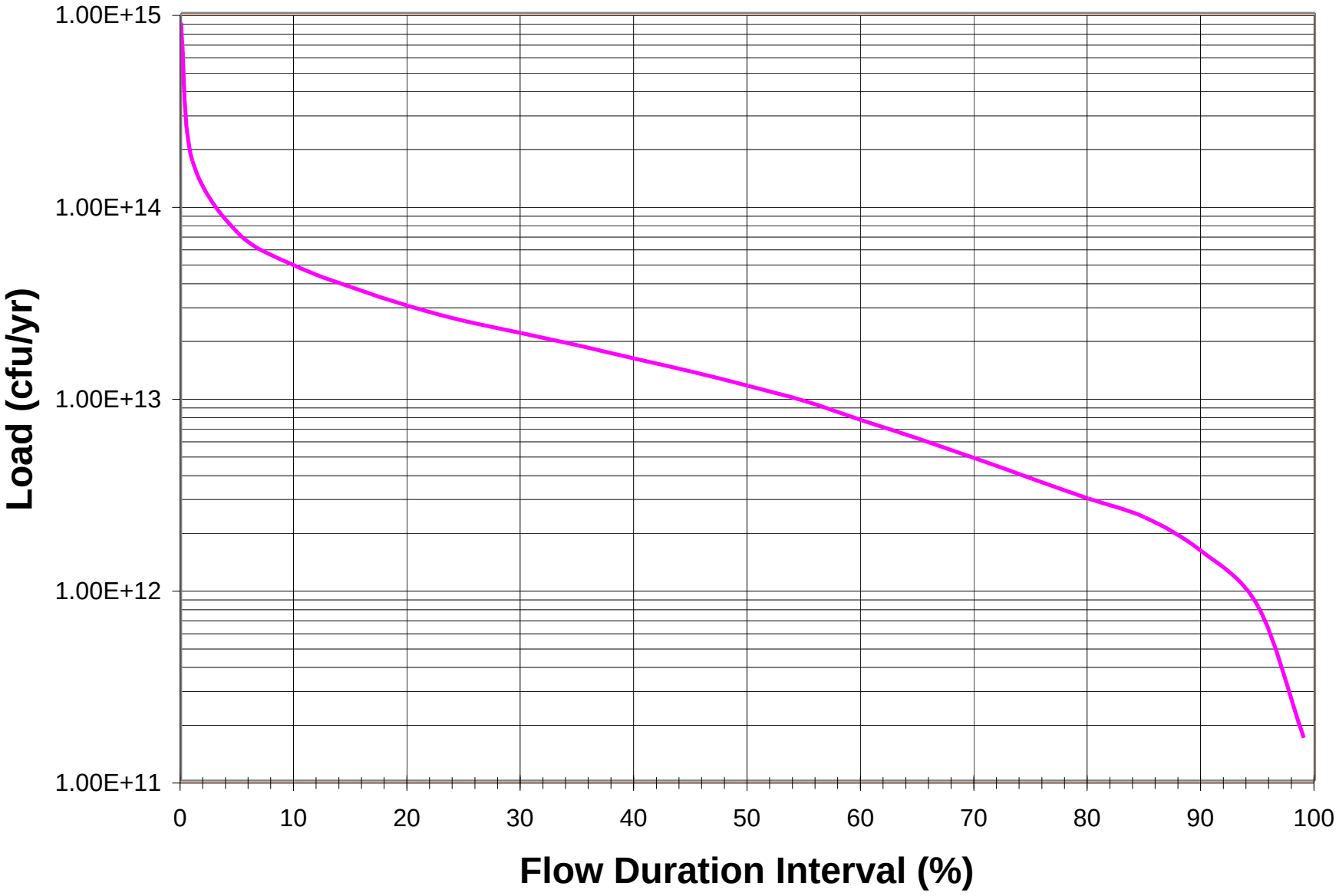
Piney Run Flow Duration Curve



Load Duration Curve

- Represents the maximum amount of a pollutant allowed at each flow level
- Obtained by multiplying the flow duration curve by the water quality criterion
- At higher flows, a stream will have more assimilative capacity
- At lower flows, it will have less assimilative capacity

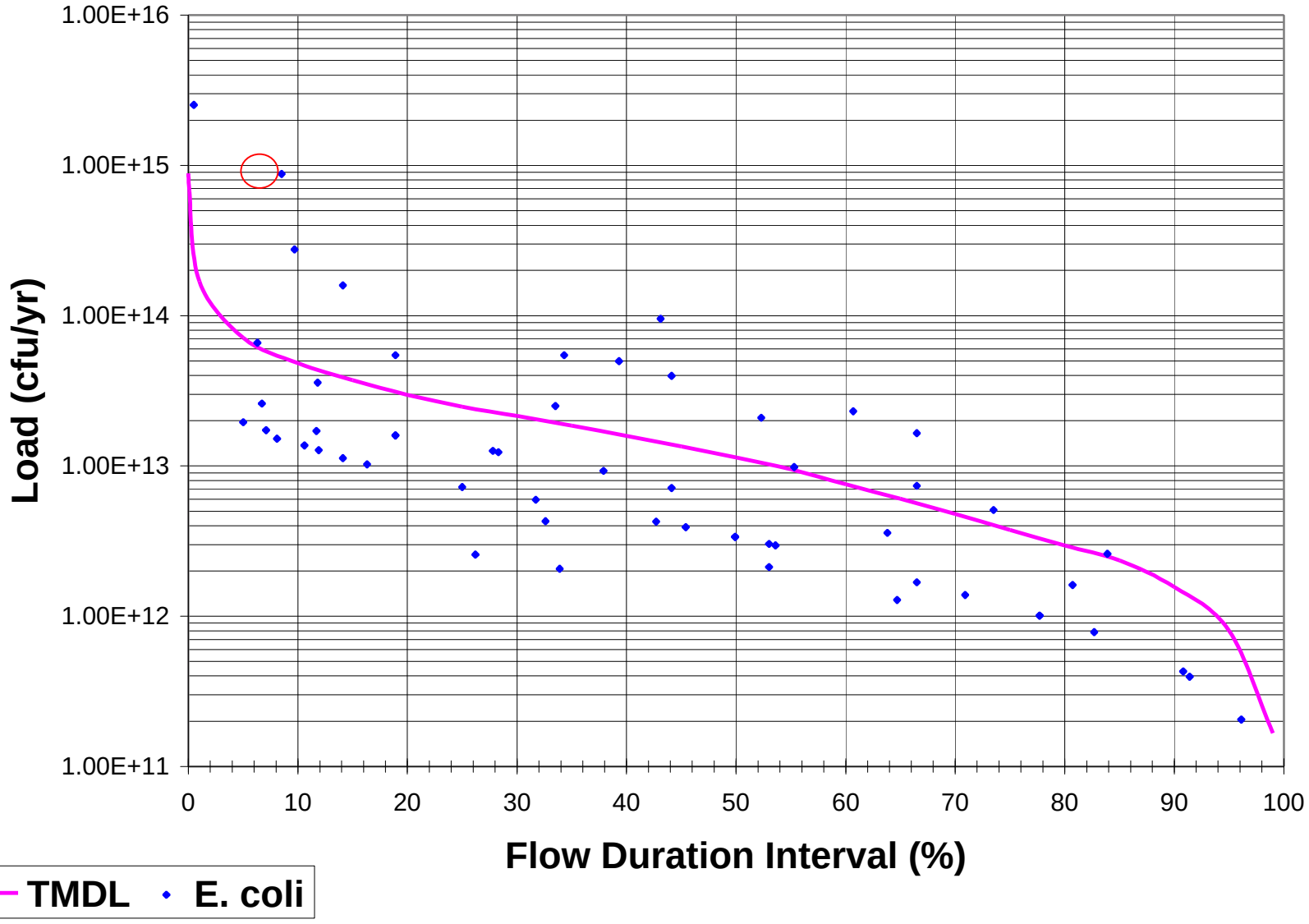
Piney Run Load Duration Curve



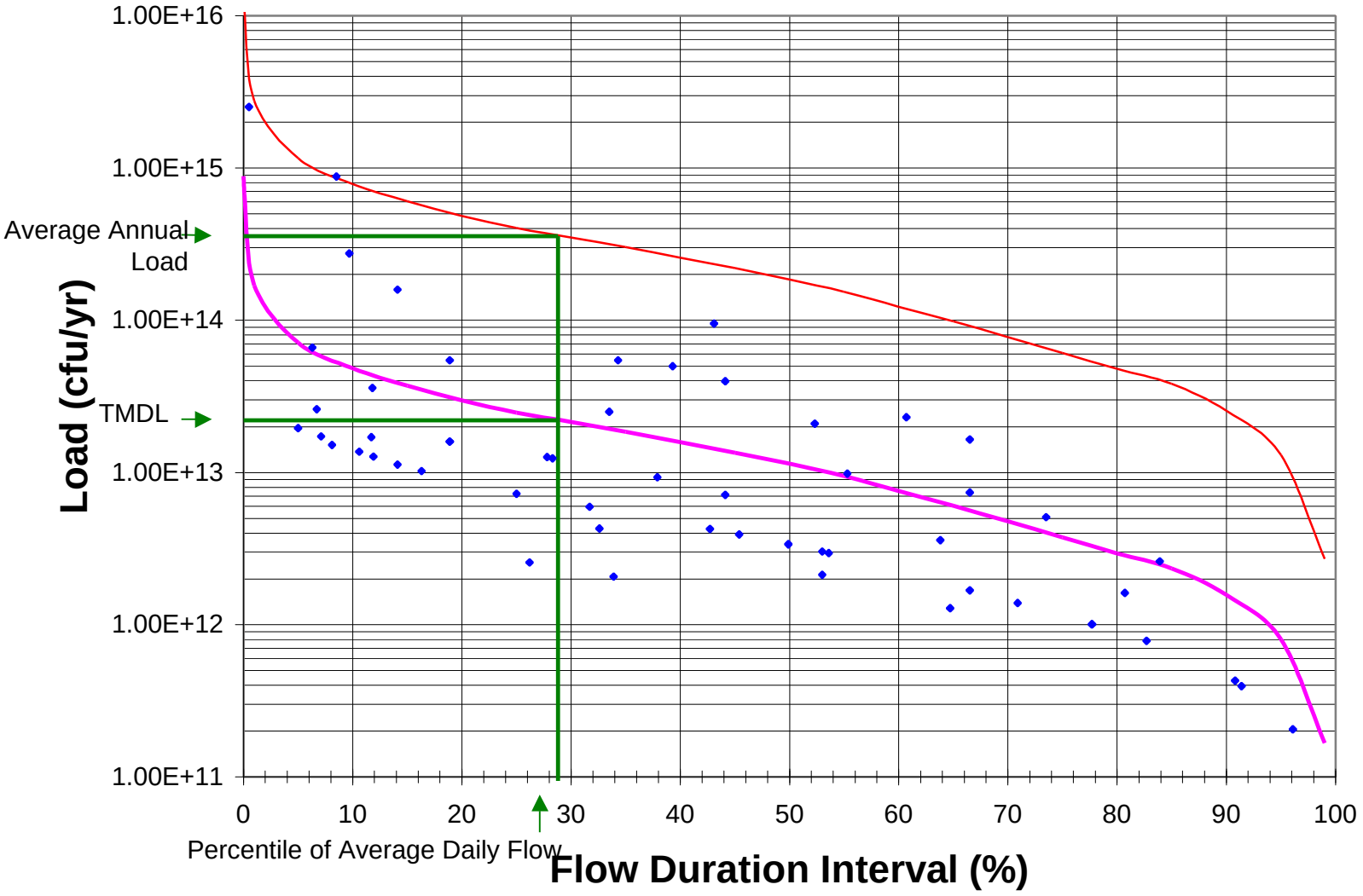
TMDL Required Reduction

- The TMDL must ensure water quality is protected during times when stream is most vulnerable
- The stream is assumed to be most vulnerable when the highest exceedance occurs
- The TMDL equation is then calculated using the maximum observed exceedance and average flow conditions (10.49 cfs)

Piney Run Observed Loads



Piney Run TMDL
(94% Reduction)



TMDL Reduction Required

WLA *	LA	MOS	TMDL
3.48×10^{9}	2.20×10^{13}	(implicit)	2.20×10^{13}

Load Category (annual average)	Allowable Loads (cfu/yr)	Average Annual EC Load (cfu/yr)	Required Reduction
Waste Load Allocation (WLA)	3.48×10^{9}	3.48×10^{9}	0%
Load Allocation (LA)	2.20×10^{13}	3.58×10^{14}	94%
MOS	0 (implicit)		
TMDL	2.20×10^{13}	3.58×10^{14}	94%

Development of TMDL Allocations

- Assume an implicit margin of safety due to conservative assumptions
- Subtract point source loads from the TMDL load to obtain the non-point source load
- Use results of BST study to allocate the non-point source loads among sources (human, pets, livestock, wildlife)

Development of TMDL Allocations

	Total (cfu/yr)	Human: 6% (cfu/yr)	Pet: 22% (cfu/yr)	Livestock: 41% (cfu/yr)	Wildlife: 31% (cfu/yr)
Average Annual Load	3.58×10^{14}	2.27×10^{13}	7.75×10^{13}	1.45×10^{14}	1.12×10^{14}
Reduction	94%	94%	94%	94%	94%
Allowable Annual Load	2.20×10^{13}	1.39×10^{12}	4.77×10^{12}	8.94×10^{12}	6.92×10^{12}

Bacteria TMDL for the Piney Run Watershed

- First public meeting:
  - Thursday, December 18
  - Discussed proposed approach
- Second and final public meeting:
  - Thursday, March 18
  - Draft report for comment
- **30 day public comment ends April 16**
- TMDL submitted to EPA by May 1, 2004

Bacteria TMDL for the Piney Run Watershed

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